

## Cosmological Parameter Estimation from CMB and X-ray clusters

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**Abstract.** We present the results of a combined analysis of cosmic microwave background (CMB) and X-ray galaxy clusters baryon fraction to deduce constraints over 6 inflationary cosmological parameters. Such a combination is necessary for breaking degeneracies inherent to the CMB.

### 1. Introduction

Since their first detection by COBE, the CMB temperature fluctuations have become an essential tool for constraining cosmological parameters. From the beginning of 2000, new experiments have released data set of good quality up to the third acoustic peak. Better constraints have been obtained on several cosmological parameters. Nevertheless, it has been shown that even with precise measurements of the power spectrum, it is nearly impossible to distinguish models with the same physical parameters on the last scattering surface. Basically, some degeneracies are inherent to the CMB. We consider in this work X-ray clusters as an independent way for constraining cosmological parameters.

### 2. Cosmological constraints from CMB and from X-ray Clusters

In the present analysis we consider the data from COBE, BOOMERanG, MAXIMA and DASI. We analysed the likelihood of inflationary models with  $H_0, \Omega_{\text{tot}}, \lambda_0, \Omega_b h^2, n, Q$  as free cosmological parameters. This corresponds to  $7.10^6$  models tested. To derive the likelihood values for the models we considered, we used the method developed in Bartlett et al. (2000), and already used in Le Dour et al. (2000).

The results are presented as two-dimensional contours plots of the likelihood projected onto various parameters planes. This 2-D presentation has the advantage of showing clearly all the degeneracies between parameters. The left contour plots of figure 1 show some degeneracies between our parameters. Basically,  $H_0, \Lambda$  and  $\Omega_{\text{tot}}$  are strongly degenerated if only CMB data are used in parameter estimation. This means that one should consider another source of constraints, independent from CMB observations, for a better cosmological parameter estimation. We choose X-ray clusters as additional constraints.

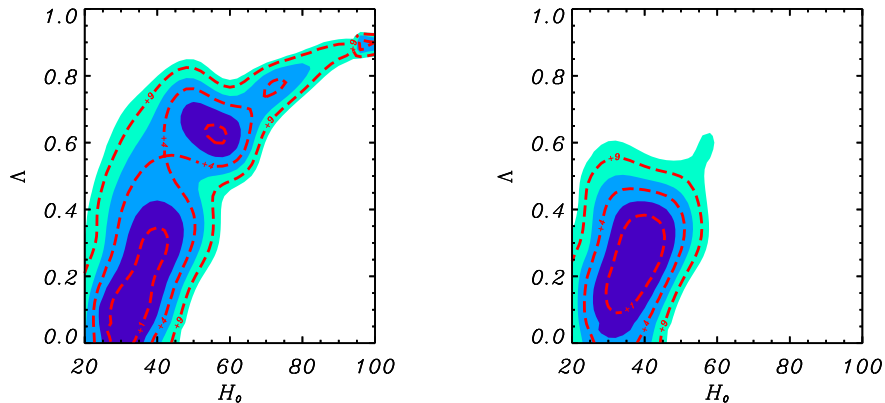


Figure 1. Constraints given by CMB and CMB plus X-ray data

Clusters are interesting object for which both the luminous baryonic mass (X-ray emitting intracluster gas) and the total gravitating mass can be determined. Therefore, an upper limit on the fraction baryon,  $f_b$ , can be estimated. Results are not necessary in agreement allowing values between  $f_b \sim 10\%$  and  $f_b \sim 20\%$ . In this work, we consider the constraints given in Sadat and Blanchard 2001 for the baryon fraction:  $f_b = \frac{\Omega_b}{\Omega_m} = 0.10 \times h_{50}^{-3/2}$  ( $\pm 10\%$ ). The aim of this contribution being to show that clusters may help for breaking degeneracies shown by CMB parameters estimations, we did not consider constraints given by other groups. A better consideration of these different results on X-ray clusters will be found in Douspis et al. (2001b).

### 3. Combined analysis and conclusion

Given the constraints of CMB and X-ray clusters, one could combined the two by multiplying the corresponding likelihood. The right figure of fig. 1 shows the constraints from the combined analysis in the same plane as the left figure. We can see that the degeneracies are broken. Confidence intervals are now determined for  $H_0$  and  $\Lambda$ . For both parameters, low values are preferred:  $25 < H_0 < 50$  and  $\Lambda < 0.45$  at 99% CL.

Due to inherent degeneracies in the CMB it is nearly impossible to specify some of the cosmological parameter; “cross constraints” are then necessary. This work is thus a preliminary view of the kind of constraints one would obtain in a near future, using last X-ray satellite data, and in a less near future the CMB satellite data (MAP and Planck).

### References

- Douspis, M. et al., 2001b, A&A, 379, 1  
 Sadat, R. & Blanchard, A. 2001, A&A, 371, 19